THE PHYSIOLOGY OF THE BLIND.

(by M. Kunz)

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VOLTA BUREAU,
FOR THE INCREASE AND DIFFUSION OF KNOWLEDGE RELATING TO THE DEAF.
WASHINGTON CITY, U. S. A.

EPRINTS OF USEFUL KNOWLEDGE
No. 56.

The Physiology of the Blind

(The Vicariate of the Senses)

By M. KUNZ
Director of the Institution for the Blind at Illzach-Mülhausen, Germany

Reprinted from The Association Review

WASHINGTON, D. C.
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THE PHYSIOLOGY OF THE BLIND.

(THE VICARIATE OF THE SENSES.)

It is a widely spread opinion that the loss of one sense produces such a strengthening of the other organs of sense, that they are enabled to become substitutes, at least to a very large extent, for the missing sense, acting, so to speak, as vicariates.

It is an actual fact that people speak of a "vicariate of the senses." Thus the loss of sight is said to sharpen the sense of hearing, and especially the sense of touch, in an almost supernatural manner. In my youth I even read in a text-book that in olden times a blind man had been appointed court tailor of a king, because he made the most beautiful many-colored clothes for him, since he was able to distinguish even the finest shades of color by the touch.

I was then at an age when you believe everything you read. It therefore became an axiom for me that the blind can "feel" colors. In after life, during my activity in middle and higher schools for seeing pupils, I did not fail to make proselytes for my opinion whenever light and heat were spoken of in the instruction in physics, and simply endeavored to seek a plausible explanation of this strange "fact."

I finally thought that I had found such an explanation in the varying degrees of heat possessed by different colored materials. I could not fully understand that colors as such could be distinguished by the sense of touch, because I reasoned this way, that if that were true, it would also be possible to distinguish odors by the touch, to see or feel sounds, and distinguish tastes by the skin. But of the "fact" I had no doubt. Nor did I consider myself alone in this view. At any rate, some eighteen years ago a prominent educator maintained in my presence that he had known a blind person who could distinguish colors with her hand. When, meanwhile, I had for several years been a teacher in an institution for the blind, and had become a heretic, I vainly endeavored to convert that gentleman to my new opinion, by telling him that the blind person in question must still have received some impressions of light, that consequently she could distinguish colors by the eye, or tell different colored wool from other indications, *e. g.*, position, size, or consistence of the balls, the texture of the material, etc. I even explained to him the method followed in our institution where totally blind girls work with materials of many different colors (wool, cotton, bristles, etc.). All in vain! He stuck to his opinion, and seemed as if he would have liked to say to me: "Your pupils have remained very backward."

When we consider how in many institutions for the blind—especially those in Romanic and Slavic countries—people fairly revel in colors, so as to heighten the admiration of the public, we cannot be astonished if such views become firmly rooted. Thus I have never seen such an orgy of colors as last year in the female work of the Naples institution for the blind (Congress of teachers of the blind at Milan). I am sorry to state that no strong opposition is raised to such entirely erroneous ideas which only too often are expressed by visitors of institutions for the blind. We meet with so many fatal prejudices which prove an injury to the blind, that we often hesitate to crush those errors, be they ever so ridiculous, which strengthen the belief in the capability of the blind, and might therefore prove useful to them.

How often do we hear people, who tell us the most incredible and impossible things of the delicate feeling of the blind, ask the questions: "But can they find their own bed, their own washbowl, etc.? Can they dress themselves, eat without aid? Do they find their mouth? Can they speak?" etc., etc.

Who will be astonished if some wag of a teacher of the blind not only does not root out these erroneous ideas in such people, which they foster with tender care, but even tells them some more fairy tales? Of course, this is not a nice thing to do, but it is easily explained. There are evidently some blind who endeavor to make themselves important by exaggerations and deceptions.

When twenty years ago I exchanged the directorship of a school for seeing pupils for that of an institution for the blind, I likewise harbored amongst the rest the fairy tale of the ability of the blind "to feel colors," but was soon cured by the blind themselves.

I had also often read and heard that the blind were able to distinguish the most infinitessimal unevenness in a body, which would entirely escape the touch of a seeing person. I consequently expected unreasonable things from the sense of touch of my pupils.

When the General Congress of teachers of the blind of Frankfurt-on-the-Main (1882), referring to my report on instruction in geography, requested me to prepare maps for the blind on the principles laid down by me, and when numberless attempts at last let me reach my object, I was not a little proud to print very sharply defined embossed or raised lines of rivers, cities, and boundaries. I examined the maps with closed eyes, and was able to follow every line with the points of my fingers, which had become hard by the continuous labor of engraving in hard wood. But when I tried to use these maps in the instruction of a class of large, intelligent girls—one of whom has been for years a teacher in a foreign country—the sense of touch failed. They did not find their way on the map. At first I thought it was obstinacy, and became impatient. Then, to please me, they deceived me, and in order to satisfy me, they pretended to have made observations which they had not made and could not have made. I found out their game, and immediately turned the geographical instruction over to a teacher whose views were not clouded by a morbid affection for "his children," and to whom the pupils, without fear of hurting his feelings, told the truth; so that I likewise learned it.

At that time the maps had been sent for examination to nearly all European institutions for the blind.

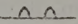
Very nearly the same replies were received from all: "Beautiful, but too fine;" "splendid, but not accessible to the touch," etc. "K. has shown himself a master of geographical representation, even if . . . ." Thus spoke the presiding officer of the geographical commission at the Amsterdam Congress. In every case there was a "but" or "if." The European colleagues were not satisfied, until I furnished maps which—besides correct representation of the mountain ranges—showed lines of rivers and rows of points, which any one could feel even with leather gloves, and which would guide even fingers with a very hard touch, like the rails guide the wheel of the car. Only after this object had been reached, the atlas, now comprising 83 maps, found universal favor and was introduced in the institutions for the blind of most civilized nations of the world (so far about 100,000 sheets have been ordered, 30,000 by the German-Austro-Danish Association for promoting the education of the blind).

In this case also I had to lower my expectation very considerably regarding the sense of touch, if I was to make myself useful to the great mass of the blind. I had the same experience with the zoological and botanical representations, and especially with those used for instruction in physics. Entirely new forms had to be prepared repeatedly, before the required accessibility to touch was reached. Today, after an experience of twenty years, I expect much less from the sense of touch, but very much more from the power of resistance of the paper.

A fully tested measure for the sense of touch—the power of the blind to localize, or their sense of space—has been furnished by the Braille pointed type, called so after their blind inventor, Louis Braille.

Not more than twenty or twenty-two years ago the raised Latin capital types (A, B, C, D, etc.) were universally used in Germany; and in this type the German Bible was printed here, 1859-1863. The blind could decipher this type and read it slowly in their youth, but only with great difficulty later in life, unless they knew the greater part of the contents by heart; this type was really intended more for the seeing teacher than for the blind. In the course of the last twenty years this type has, in spite of the most violent objections of many teachers of the blind, been completely ousted from the printing offices, and been replaced by the pointed type.

The basis of this last-mentioned type is formed by two perpendicular rows of 3 points, each (⠿ the French é).

These conical points  were, twenty years ago, 3 millimeters distant from each other—measured from point to point. (Measured at the base 4 millimeters.) These measurements, suitable for the fingers of the blind, had been found in a purely empirical way. To save space, these measurements were reduced to 2½ and 3½ millimeters, respectively, in France even to 2¼, and 3 millimeters at the base. But it soon became apparent that, as far as the majority of the blind was concerned, the limits of the sense of touch, and of legibility, had been exceeded. Our blind find great difficulty in reading the editions of the French classics printed in this type. Consequently, Germany, Austria, etc., have returned to the old measurement of 3 millimeters at the points (obtuse points or cones). For simultaneous apprehension the "bridges" or "distances" measuring less than 3 millimeters were too short. Motions of touch consuming time—successive apprehension of the points—were required which made rapid reading impossible. For the *simultaneous* apprehension of several obtuse points by the blind, the "distance"[1] between the points should be 3 millimeters.

That is the result of many years' experience at the institutions for the blind. Measurements by the compasses, in order to find the uttermost limit, *i. e.*, the shortest distance at which two points can be apprehended by the touch as two points and not as a single one, had been taken with but very few blind, or one individual only, by Weber, Czermak, Goltz, Gärttner, Goldschneider, Uhthoff, Hocheisen, and recently by Dr. Th. Heller.

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[1] In the following the term *"distance"* has been used for short, to indicate the distance at which two raised points of the type for the blind can be felt by the finger as *two*, and not as *one*.

American physiologists have also examined the sensorium of two deaf-blind, Laura Bridgman and Helen Keller.

In these last mentioned cases experiments were made with only one person. Furthermore, all these measurements have been taken with very primitive instruments, ordinary compasses, which could not furnish any data *concerning the strength of the pressure which after all has a decided influence on the result* (since the number of erroneous observations increases with the increased pressure.—Griesbach.) And yet, general conclusions have been drawn from this limited and partly unreliable material!

Whilst all the older investigators still speak of the great superiority of the sense of touch of the blind over that of seeing persons, Uhthoff admits, in a somewhat timid way, that in *one* person whom he had examined, and Heller, that in several persons examined by him (he principally speaks of two), without publishing exact results, there is "a not very perceptible sharpening of the sense of touch." He adds—and we quote his own words: "As the experiments made by means of compasses are as unsatisfactory as the former experiments regarding the sense of space, I refrain from publishing the data obtained." We, therefore, do not learn on what his timid assertion regarding the "not very great superiority" of the blind is based. In Helen Keller, likewise, nothing important in this respect was discovered.

So far, therefore, no definitive results have been obtained, nor could be obtained, because the measurements were limited to *too small* a number of persons, and *had been taken with unsuitable instruments.*

I was, therefore, exceedingly pleased when three years ago Prof. Dr. Griesbach, President of the German Association for school-hygiene, requested to be permitted to take a series of measurements on the pupils of our institution, with the view to institute a comparison between the strength of the sense of touch in blind and seeing persons of the same age.

When in a slightly doubting manner he spoke of the "vicariate of the senses," and the alleged superiority of the senses of touch, hearing, and smell in the blind over those of seeing persons, I told him plainly that, after my experience, I had no faith in these assertions, and that most blind would hardly distinguish the two points of his æsthesiometer at distances of less than 2 millimeters, as two separate sensations, by the point of the reading finger.

Prof. Dr. Griesbach, therefore, entered upon his investigation without a firm faith in the old dogma of the vicariate of the senses, but also without the intention to destroy it. I placed all our pupils at his disposal, and let him select the persons on whom experiments were to be made, so as to avoid all suspicion of my influencing the result by selecting pupils with a specially fine sense of touch or pupils who were not very bright. As he did not know any of them, he actually selected pupils of greatly varying capability, mostly those who had not yet begun to receive instruction in a trade, but who, outside of the common instruction received instruction only in some manual labor, or in music.

By means of his new æsthesiometer—with parallel pins on springs—he examined the spaces (the smallest distances at which impressions of two points can be felt as two sensations) on the forehead, the cheek bone, the point of the nose, the lips, the thick part of the thumb, and the points of the forefingers of both hands.

By means of Zwaardemaker's olfactometer observations regarding the sense of smell were taken in the long rope-walk, in the corridor of the female department, about 40 meters long, regarding the distance at which sounds can be distinguished, and in our garden, by means of the angular mirror (Winkelspiegel), regarding the localization of the direction of the sound.

For the sake of comparison, pupils of the public schools of Mülhausen of the same age were examined in exactly the same manner as the blind. The results of thousands of observations were entered in eighty-nine tables, in such a manner as to place the blind side by side with the seeing.

I. Distinguishing the Direction of the Sound.

At the celebration of the jubilee of the institution for the blind at Lausanne, the well-known oculist, Prof. Dr. Marc Dufour, made the statement that, according to his observations, blind persons were better able than seeing ones to indicate the direction of the sound, and in connection therewith asked the question whether it would not be advisable to appoint blind persons on vessels for accurately determining in foggy weather the direction of [illegible]s made by other vessels or the location of landing places, as they could do this more accurately than seeing persons. Without furnishing any data relative to the method of observation employed by him, he states that the 19 blind examined by him, in indicating the direction of the sound made only 6 per cent of mistakes, whilst the seeing ones made 13 per cent.

He did not inform us under what conditions these observations had been made, and what had been the number of observations leading to the above result. Griesbach has thoroughly examined 28 seeing and 28 blind persons. Nine experiments were made with each one of these 56 persons, three of each on one ear (whilst alternately the other was closed up with moistened cotton), and three each on both ears.

Three perfectly faultless observations were furnished:

(*a*) With the left ear: 1 seeing person, no blind.
(*b*) With the right ear: none.
(*c*) With both ears: 3 seeing persons, 1 blind.

The average error as regards the left ear was 16° 23″ in the blind and 17° 9″ in the seeing ones; difference in favor of the blind, 0° 46″.

As regards the right ear: Blind, 19° 53″; seeing persons, 17° 40″; difference in favor of seeing persons, 2° 13″.

As regards both ears: Blind, 11° 47″; seeing persons, 10° 7″; difference in favor of seeing persons, 1° 40″.

The average of all the observations shows for the 28 blind an average error of 15° 35″, and for the 28 seeing ones, 15°.

In 252 observations the blind have indicated the direction of the sound correctly 68 times and the seeing 82 times.

Better results were obtained, with the exception of two persons—one seeing and one blind—with both ears than with one ear.

Therefore, as regards distinguishing the direction of the sound, no essential difference could be shown between the seeing and the blind, though there was an infinitessimal difference in favor of seeing persons.

II. Distance at which Sounds can be Distinguished.

The very extensive Tables XVIII-LXXI, mostly extending over two pages each of Griesbach's work, furnish data regarding the distance at which sounds can be distinguished, the acuteness of the sense of smell, and the acuteness of the sense of touch, in seeing and blind.

The examination relative to the distance at which sounds can be distinguished by seeing and blind took place in long corridors. Numbers from 1 to 100 and words of one syllable were spoken in a sharp whispering tone of voice. In this manner 49 seeing and 19 blind were examined. Several blind had been *excluded* from the *examination* because their organs of hearing could not be considered as normal.

The blind who could hear best could distinguish words with one ear at a distance of 45 meters (1 meter = 39.37 inches), and with the other ear at 40 meters; but a seeing person showed almost the same results.

The average distance at which sounds could be distinguished was in 19 blind and 49 seeing, right and left ear, exactly 26 meters.

This proves that the sense of hearing has gained nothing by the loss of sight.

The *musical* ear has nothing to do with the distance at which sounds can be distinguished. Nevertheless, there are men hard of hearing who can hardly distinguish human speech, because they hear only the vowels but not the consonants, and who still accurately distinguish musical sounds, even if they sound fainter to them than to persons with a normal sense of hearing. But the faintest musical sound is still "louder" than a (mute) consonant. The cortical organ of the inner ear, which is the intermediary for distinguishing the degrees of sound, is entirely independent of the eye, as independent as is the piano of the spectacles of the player. But no experienced teacher of the blind, who has to instruct many musical blind, will maintain that the musical ear of the average blind is naturally superior to that of the average seeing person. Only more care is taken in institutions for the blind to develop any talent, by imparting instruction in music to all the pupils, and by not dispensing with this instruction until all attempts have failed.

III. THE ACUTENESS OF THE SENSE OF SMELL.

This was measured by means of Zwaardemaker's olfactometer, which is described in Griesbach's work.

A glass tube encloses a rubber tube, and this again a glass tube of the same length, with a handle (smelling tube). As long as the rubber is covered by glass on the outside and inside, no smell can be noticed.

If you pull out the "smelling tube" one centimeter, an equal length of the rubber tube in the inside remains uncovered, and imparts to the air in smelling (at the handle of the tube) a peculiar smell. In proportion as the smelling tube must be pushed out more or less, until the smell is noticed, the organ of smell is more or less sensitive. It can consequently be defined according to the length of tube pulled out.

Both nostrils were examined.

In 20 blind the tube had, on an average, to be pulled out, for the left nostril 1.56 centimeters and for the right nostril 1.94 centimeters, before the smell of the rubber could be noticed. In 40 seeing persons 1.16 centimeters sufficed to bring about this result, and in 24 other seeing persons 1.14 centimeters.

As regards the blind, the average is therefore 1.75 centimeters; as regards the seeing persons, 1.15 centimeters. Difference in favor of the seeing, 6 millimeters.

IV. ACUTENESS OF THE SENSE OF TOUCH.

We now get to the main point, the sense of touch, to which, in the blind, the most incredible magic powers are ascribed. It probably has never been asserted that the blind could smell or hear colors, but very often that they could distinguish them by the touch. And still the one would not be more marvelous than the other.

The question was, therefore, to ascertain at different parts of the body at what minimum distance two simultaneous pricks of the pin can be distinguished as two different sensations, and not as one. As I said above, the observations were taken by means of Griesbach's new æsthesiometer (parallel pins or springs with nonius).

The observations extended to the forehead, the cheek-bone, the point of the nose, the lips, the thick part of the thumb, and the points of both forefingers. The observations were made partly on holidays, partly after school hours, partly after instruction in manual labor, and extended to 37 blind and 56 seeing.

First, 10 blind and 15 seeing were examined after mental work (instruction). The distances between two points at which they can be felt as two by the touch showed the following averages in millimeters:

I.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	4.5	4.9	1.86	1.72	4.8	1.49	1.91
Seeing	4.2	4.4	1.55	1.36	4.1	1.36	1.38
Difference in favor of the seeing	0.3	0.5	0.31	0.36	0.7	0.13	0.53

The seeing, therefore, showed a finer sense of touch than the blind. As regards the forefinger of the right hand, which specially interests us, the difference is 0.53, therefore more than one-third of the total of the seeing.

The examination of 15 blind and 15 seeing on holidays showed the following results, in millimeters:

II.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	3.6	3.7	1.7	1.5	3.77	1.29	1.55
Seeing	2.46	2.59	0.85	1.01	2.41	0.72	0.65
Difference in favor of the seeing	1.14	1.11	0.85	0.49	1.36	0.57	0.90

Here the difference is still more striking, as in the thick part of the thumb it amounts to almost 1½ millimeters, and at the forefinger of the right hand to 9/10 millimeters. *In order that the blind might, with the forefinger of the right hand, alleged to possess a particularly acute sense of touch, feel two points as two and not as one, the points had to be put at twice the distance (1.55 instead of .65) as for the seeing.*

The examination of 16 blind and 19 seeing after labor of several hours in the workshop (2 to 2½ hours for the blind) showed the following results (averages), in millimeters:

III.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	5.97	5.84	2.275	2.0	6.0	1.7	2.0
Seeing	4.20	4.40	1.50	1.32	4.43	1.5	1.4
Difference in favor of the seeing	1.77	1.44	0.775	0.68	1.57	0.2	0.6

The same striking difference! Measurements as regards 15 blind and 13 seeing (excepting only one) in free time showed the following results, in millimeters:

IV.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	3.2	3.2	1.5	1.4	3.15	1.2	1.37
Seeing	2.5	2.5	0.9	0.9	2.93	1.1	1.15
Difference in favor of the seeing	0.7	0.7	0.6	0.5	0.22	0.1	0.22

Also in this case the proportion does not change very much. Seven blind (ages 12-16 years) after manual labor—plaiting—and 7 seeing of the same age after *labor in workshops*, showed the following results, in millimeters:

V.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind.	5.5	6.1	2.20	1.8	5.6	1.51	1.77
Seeing	4.1	4.5	1.67	1.4	4.6	1.41	1.30
Difference in favor of the seeing	1.4	1.6	0.53	0.4	1.0	0.1	0.47

Likewise after mental work:

VI.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	4.3	4.7	1.9	1.8	4.9	1.49	2.01
Seeing	4.3	4.6	1.71	1.47	4.2	1.3	1.3
Difference in favor of the seeing	....	0.1	0.19	0.33	0.7	0.19	0.71

The examination of 2 blind girls and 2 seeing servant girls of the same age has (as regards the blind on holidays) shown the following results, in millimeters:

VII.

	Forehead.	Cheek-bone.	Point of the nose.	Lips.	Thick part of the thumb.	Left fore-finger.	Right fore-finger.
Blind	3.75	4.0	1.75	0.5	2.5	1.12	1.75
Seeing	2.75	3.25	1.25	1.35	3.5	0.8	0.8
Difference in favor of the seeing	1.0	0.75	0.50	0.15	1.0	0.32	0.95

Here the difference is still more striking, especially because the two blind girls had particularly fine, delicate fingers, and had, in addition to the usual instruction, been employed only in knitting and similar work, whilst one of the two seeing girls served as chambermaid, and had evidently, when living in the country, worked in the fields. The spaces, as regards the right forefinger of the blind, are more than twice the size of those of the seeing! But entirely incomprehensible—from the point of view of the old dogma—were the results of an examination of two deaf-blind girls, one of whom, Magdalena Wenner, reads fluently, and finds her way on the map better than many pupils endowed with all their senses.

If nature really compensated with the one hand what it takes with the other, the three senses which these girls still possessed should have been extraordinarily strengthened; and still we find in them the most unfavorable results, i. e., not the least acuteness of the sense of smell (3.5 and 2.75), but also the largest spaces, viz:

M. W. (after instruction)........	7	7	4	3.5	1	2.5	3.5
" (on holiday)...............	5	5	2	2	3.5	1.5	2
O. H. (after knitting, etc.).......	10	12	3.5	3	8	2.5	3

Where is, in this case, the vicariate for the two lost senses? I cannot find it.

M. W. owes her very considerable accomplishments not to a compensation by nature, *i. e.*, by nature strengthening the three remaining senses, and thus compensating for the loss of sight and hearing, for even the senses of smell and touch appear in her considerably weakened. Only in consequence of her extraordinary intelligence has the difficult labor of her educators borne rich fruit.

Tables LXXII and LXXXIX of Griesbach's work show the results of about 3,000 experiments made on seeing and blind, with the view to ascertain the frequency and direction of the so-called "erroneous observations." As these observations are only very slightly connected with the vicariate of the senses, I can pass them over, all the more as there does not seem to be any difference in this respect between the seeing and the blind. We therefore return to the tables showing the acuteness of the sense of touch.

They show everywhere greater distances between the points (Schwellenwerte), therefore a less acute sense of touch in the blind than in the seeing; and the difference is particularly striking in the right forefinger. Whilst the average difference in favor of the seeing is 0.24 millime[illegible] for the left forefinger, it is 0.90 for the right.

If we now compare these figures with those of the blind, we find 1.66 millimeters for the left and 2.02 millimeters for the right forefinger.

On holidays these distances go down to 1.20 and 1.50 millimeters, respectively. *As a general rule the right forefinger of the blind finds its way less perfectly than the left, whilst there is no such difference in seeing persons.* Only in 4 of the 37 blind examined we find larger distances for the left than for the right; *they were persons who generally or exclusively read with the forefinger of the left hand.*

In 10 others the distances for the left and right forefinger are the same. Such blind *read with both forefingers,* letting the one immediately follow the other; or they have entered the institution late, have barely learned to read, and take no pleasure in it. With all the others, who *principally* read with the right hand (in copying all read with the left, and write with the right hand), the distances are *greater for the right than for the left hand.*

Unfortunately, not *all* the fingers were subjected to an examination. It is probably that for all non-reading fingers we would find shorter distances than for the forefingers.

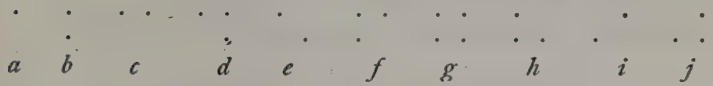
The "reading-finger," the capabilities of which are so much admired by outsiders, has therefore in fact a *less* acute sense of touch than the finger which only plays the part of an assistant, and this finger is probably less sensitive than its idle colleagues. This shows that reading *blunts* the sense of touch, because the finger ends by the constant rubbing on the raised points become hard and *leathery,* because the epithelium becomes thick. The best readers who read almost as fast as seeing persons, show distances for the reading finger of 2, 2.6, and even 3 millimeters (Griesbach's Tables LV, LIX, LI, XXVIII).

They therefore appear as being hard of touch, considering that in the seeing who were examined and who do not read books printed for the blind, the average distance for the forefinger was only 1.1 millimeter. The blind in whom the distances approach those of seeing persons, *i. e.,* are less than 1.5 millimeters, read as a rule little and poorly (LVII, XL, VII, XLIV, etc.), or at least not as well as those who have a harder sense of touch. *It is not rough manual labor which spoils the sense of touch,* as has been maintained, for those who required the shortest distances, 0.5 and 0.8 millimeters (XLVII and LVII) were *basket makers.* Both of them read poorly, although they are very intelligent.

The question now arises: Why can seeing persons with an "acute sense of touch" not read books for the blind, or can only decipher them with difficulty, whilst the blind with a much less acute sense of touch read so fluently that you might think they were reciting?

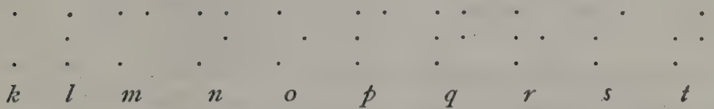
The present type used for books for the blind (the Braille-type) consists, as has already been stated, of raised conical points, 2¼-3 millimeters distant from each other. (I have already stated that the distance between the points below 3 millimeters has been abandoned in Germany and Austria.)

The forms are as follows: ⠿ = é



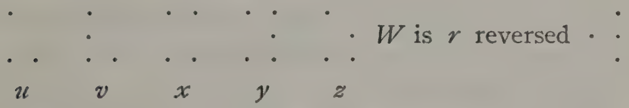
For the second series of ten letters one point is added below in the first perpendicular row:

(*a* + · = *k*; *b* + · = *l*; *c* + · = *m*, etc.)

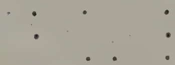


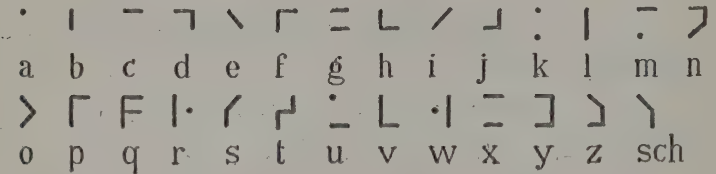
For the third series one point is added below in the second perpendicular line:

(*k* + · = *u*; *l* + · = *v*; *n* + · = *y*; *u* + · = *z*)



W is *r* reversed

In the books the distances of the letters from each other are hardly greater than the distances of the points of one and the same letter from each other, *e. g.*, ⠝⠥⠗ = *nur* (German for "only"). The tip of a finger 15–17 millimeters broad, therefore, in the preceding word "*nur*" covers, when its central part rests on the "*u*," not only the "*u*" but also the second perpendicular row of the "*n*" and the first perpendicular row of the "*r*" ⠗ As the end of the finger is round below, , the points of the "*u*" in the middle will impress themselves deeper into the finger and affect it stronger than the points of the letters on either side  "*n*" and "*r.*" *A finger having a very acute sense of touch will also feel the weaker impression of the letters on either side and mix up the letters, i. e.*, not know which points belong to one and the same letter, whilst a finger not possessed of *so acute a sense of touch will hardly take notice of the weaker impressions* produced by the letters on either side. In order to prevent such mistakes, which make the requirement of reading very difficult if not impossible to persons who have become blind later in life, I have had a book printed where, for the benefit of such blind, relief-*line* types have been used, combining or uniting the points to make figures:



But we find in Griesbach's tables in 33 blind out of a total of 37—but only in 5 seeing out of a total of 56—the observations, "If the impression is weak, there is no sensation of touch;" or "if the impression is below 2, below 5 g, the blind can make no exact statements as regards the sensation of touch," etc.

This discovery—*and it is decisive*—we owe to Griesbach's æsthesiometer working on springs. With the ordinary compasses which were formerly used in the few measurements that were taken this fact *could not be ascertained.*

The four blind, concerning whom we find no such observations, had not made much progress in reading, *i. e.,* they had only read when they were obliged to, or had just begun to learn reading. The epithelium of their forefingers had, therefore, not yet become thick. We find among them again case XLVII, which shows the shortest distances (left, 1 millimeter; right, 0.5 millimeter).

I must here insert the remark that the ability to read by no means furnishes a standard for skill or talent for manual labor. The best readers are, as a rule, the worst workmen.

From what has been said above, it appears beyond a doubt that for learning to read with the fingers, the sense of touch should not be rendered very acute, but it needs rather to be blunted.

A seeing person cannot read books printed for the blind, *for the reason* that he receives too lively an impression of the points *on either side,* therefore *feels too much.*

An Italian physician, Dr. Ferrai, has recently in examining some deaf ascertained that the acuteness of touch increases with age. Up to what limit, he does not say.

A person who thoughtlessly, or wrapped in deep thought, wanders through the streets of a populous city, "sees" the surging crowd before him, to the right and to the left, and after all has not seen anything properly, because his field of vision was too extended, because he could not fix any one impression. A finger possessed of an acute sense of touch experiences the same when brought in contact with the swarm of points of the type for the blind, whilst the blunted reading finger may be compared to the weakened sense of hearing which only hears the blasts of the trombones and the thumping of the kettle drums in a full orchestra. Practice makes perfect, and practice in our case means nothing less than the thickening of the epithelium, and the weakening of the sense of touch connected therewith, *presuming the degree of acuteness of the sense of touch can be determined by æsthesiometric measurements.* I feel sure that this assertion will in those large circles which cannot tear themselves away from the dear old faith, be considered as heresy. But its correctness is proved beyond the shadow of a doubt by Griesbach's experiments and my knowledge of the blind on whom these experiments were made. It is also confirmed by the fact that when the blind want to distinguish dry goods—silk, wool, cotton—they do not, as a rule, use the reading finger as the organ of touch.

I will candidly confess that not a very long time ago I considered the best readers as possessed of a particularly acute sense of touch, and that I felt like *a burglar in a church when I first penned with a palpitating heart the above statements.* I had never been able to explain to my own satisfaction why the best readers generally show no skill in manual labor, and even show themselves clumsy in the common acts of everyday life.

Not until I critically examined Griesbach's tables were my eyes opened.

I only regret that the measurements were not extended *to the ends of all the fingers of both hands, and to persons of greatly differing age.* This *must* be done at some future time, so as to corroborate the results gained so far.

This omission has since been corrected. During the Whitsuntide holidays of 1902, Griesbach took measurements on 2 blind and 3 deaf in the Institution for the deaf and blind at Weimar, and this time extended his investigations to *all fingers.* The results, which reached me only a few days ago, are as follows:

Born blind; age 12 and 13; figures express millimeters:

	Forehead.	Cheek-bone.	Point of the nose.	Thumb.		Little finger.		Ring finger.		Middle finger.		Fore-finger.	
				Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.
I. 12 years.......	5.5	8.0	4.0	2.2	2.2	1.3	1.4	1.2	1.2	2.0	2.0	1.5	2.3
II. 13 years......	5.5	7.5	4.0	2.7	2.2	1.2	1.3	1.2	1.2	1.5	1.5	2.0	2.5
Average.....	5.5	7.75	4.0	2.45	2.2	1.25	1.35	1.2	1.2	1.75	1.75	1.75	2.4

Average of distance for all fingers: 1.745 millimeters. Average for the 7 non-reading fingers, 1.45 millimeters.

The supposition expressed by me *that the distances for all non-reading fingers must be shorter than for the reading finger has therefore been proved to be well founded.*

Deaf of the age of 10, 12, and 13 years; figures express millimeters:

	Forehead.	Cheekbone.	Point of the nose.	Thumb.		Little finger.		Ring finger.		Middle finger.		Fore-finger.	
				Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.
10 years..........	8.5	12.5	4.5	2.5	2.5	2.0	2.0	2.0	2.0	2.2	2.2	2.2	2.2
12 years..........	8.7	12.0	4.0	2.0	2.0	2.2	2.2	2.5	2.5	2.2	2.3	2.0	2.0
13 years..........	8.5	10.5	3.5	2.5	2.5	2.5	2.2	2.5	2.5	2.3	2.2	2.5	2.5
Average.....	8.23	11.7	4.0	2.33	2.33	2.23	2.13	2.33	2.33	2.23	2.23	2.23	2.23

Average distance for all fingers, 2.26 millimeters.

It should be stated that these observations were taken during the vacation and that the pupils were not hard worked, either mentally or physically, prior to the vacation.

Whilst with the deaf there is *no essential* difference of distance for the different fingers (the average varies between 2.13 and 2.33), we find for the reading fingers of the blind distances of 2.4 millimeters, whilst the non-reading fingers, apart from the thumb, show an average distance of only 1.44 millimeters. According to Table IV, the latter approaches that of the seeing for both forefingers (1.3 mm.).

These measurements show furthermore that the deaf, by losing their hearing, have not gained anything as regards the acuteness of the sense of touch, but that, on the contrary, they have lost a great deal.

And this people called a vicariate of the senses!

One might be tempted to believe that I underestimate the value of the sense of touch and the capability of the blind. After the labor of more than twenty years with and for the blind, I think I do not deserve this reproach, if it ever should be made. I know from experience that today we are able to raise the normally endowed blind, also as regards scientific attainments, to the level of the seeing of the same age; and that, as regards technical acquirements and skill in those trades which are open to them, they are very little behind the seeing. The sense of touch accomplishes *much more* and *much less* than outsiders generally imagine. Usually the blind are considered as sorcerers and idiots at the same time. They are neither the one nor the other, but human beings with reduced strength (for, where one member suffers, all suffer), but who, by a *careful education,* by *diligence* and *perseverance,* not through magic power, are able to a great extent to recover of what nature has deprived them. How erroneously the blind—and the sense of touch in general—are judged even by prominent men of science, is shown by the words of a man like Wundt, quoted by Griesbach; Wundt is of opinion that the sense of touch which always remained at a low grade of development in the seeing, reaches a development in persons born blind "which, as regards the acute power of distinguishing, rivals the regions of indirect sight of the sides of the retina." (Wundt: Menschen- und Thierseele, p. 167.)

That is by far too much and by far too little! When we walk through a street or through a forest and look straight ahead, we involuntarily see with the sides of the retina to the right and the left, above and before us, millions of objects in *indistinct outlines* which are not accessible to the sense of touch of the blind. But those objects which are placed in the hands of the blind, and are enclosed by them, are grasped by the sense of touch *as they are and not as they seem,* whilst to the eye, when we move round about them, they assume different forms from second to second, because the eye only sees perspectively and by projection. A globe is and remains to the feeling hand a globe, but to the eye it is an unevenly lighted flat circle. A suitably shaded circle in a drawing therefore produces an optical illusion, and appears to the eye, on the strength of numerous experiences of the sense of touch, as a globe.

Spherical bodies which are not accessible to the sense of touch have, therefore, for thousands of years been considered by men as circular disks—the moon, the sun.

Some years ago I received from Vienna a number of intagliated plaster casts of relief medallions of historic personages. After inspecting them for some time, it suddenly struck me that at one time I saw them intagliated and then again in relief. To obtain the certainty that this deception was not simply caused by a peculiarity of my eyes, and also with the view to convince some seeing persons of the fallibility of sight, I placed these plaster casts against the wall, so that they could be seen in front from some distance, but could not be touched.

I then called two of my seeing colleagues and showed them the beautiful "relief casts." They shared my admiration, and did not notice that something was wrong until I laughingly asked them to take a little closer look. Then of course they discovered that these casts were made in entaglio and not in relief. They would of course not have made the mistake if they had thought of the direction of the light, *i. e.,* the location of the window. I made similar experiences in innumerable cases, when for some time I looked steadily at the back (the hollow side) of my zoological relief objects. The sense of touch will never make such mistakes. A blind person with a practiced sense of touch, who carefully goes over an exact model of the Vosges mountains or the Alps, gets a much more correct and "more plastic" *total impression* of these mountains than a traveler who by rail travels a thousand times from Basel to Strassburg, or passes through the Alps, but who only gets a side view of the mountains (in projection on a vertical plane), and never from above (in projection on a horizontal plane [map]) as a whole. Only the impressions are of a different kind.

Impressions received by the sense of touch cannot be compared with impressions received by the sense of sight. They are as different from each other as painting and sculpture, but, like these, of *equal value.* The seeing person can do a thousand things which a blind person could not do; just as the blind can do many things which the seeing could not do in the dark, because every conscious action or labor is a result of the mental life which, as far as space is concerned, in the seeing is mainly built up by impressions from light, but in the blind by impressions from touch (attempts to see by persons born blind, on whom an operation has been performed). The eye from a suitable distance takes in the largest and smallest objects as a whole, and only afterwards analyzes them; the sense of touch does not take in very small objects; and those which are so large that they cannot be enclosed with the hand or show complicated forms it only takes in *gradually.* The sight as such furnishes *groups* of impressions, whose component parts lie side by side in a plain; the sense of touch furnishes, as far as larger objects are concerned, a *series* of impressions, the parts of which follow each other in order of time, and which are only grouped by a psychical act (synthesis). Sight is the sense of plains, touch the sense of bodies.

A person blind from birth can easily have correct impressions of bodies, whilst it is much more difficult for him to get an impression of a plain. A "*touch*-blind person, born as such—I don't know whether there are such persons—would probably by means of sight get a correct impression of plains, but no impressions of bodies. In a person endowed with all his senses impressions from sight and touch blend to one grand total impression comprising both plains and bodies; so that impressions by sight also reproduce closely related impressions by touch, *i. e.,* impressions of bodies, and *vice versa.* When we "see" the *front* of a house, *i. e.,* when we perceive the waves of light which are reflected from this front, we say: "I see the house," because we no longer separate the impression of a body produced by the sense of touch from the impression of a plain. Sight and touch, which belong together, but which according to their nature are intended to receive totally different impressions of the outer world, may therefore supplement each other, but never *take each other's place.* There can, therefore, not be any vicariate of these two senses, although they are so close to each other that sight has frequently been termed "touch from a distance." Much less can hearing take the place of sight, for these two senses are totally different.

Hearing alone cannot produce any impressions of space, although it can locate the direction of the sound with tolerable accuracy. The distance of the source of the sound is not determined by the ear itself, but is estimated—in most cases very inaccurately—by the strength of the sound. But the impressions of space, on which this estimate is based, have been gained by sight and touch.

The blind person, of course, gets his defective impressions of larger spaces by the sense of touch, when the feet as organs of touch in connection with the "sense of the muscles" (Muskelsinn)—length of the steps—are taken into consideration. But these two senses do not furnish direct impressions of space, but only material for such. Here likewise intelligence has to come in as the formative power by the aid of numbers and time. As far as hearing is to serve the communication of men with each other, it is destined only for the perception of conventional groups of sounds (words, etc.) for impressions and ideas. It is true that only too often teachers of the blind entertain the erroneous idea that words *produce* impressions of space and of objects; there is too much talking and too little object-teaching. The former is, of course, much easier. There can, therefore, be no talk of the ear taking the place of the eye. And that the loss of sight does not strengthen and sharpen the sense of hearing, as regards space, has been proved by the locating of the direction of the sound and the distance at which sounds can be heard.

The greater attention which the blind person gives to insignificant noises, which can guide or warn him, does not seem to influence his organs of hearing. The attention is a psychological and not a physiological element.

The view that the loss of one sense, of itself and always, *i. e.*, by natural necessity, strengthens the other senses; that, for instance, the energy having, so to speak, become disposable by the non-use of the nerves of sight, passes over to the nerves of the other senses, just like the property of a dead child passes to his brothers and sisters and increases their possessions, has by Griesbach's investigations been shown to be erroneous—as far as smell, sight, and touch are concerned.

He states the following in his conclusions (16), which I here give in full:

1. In the faculty of distinguishing impressions produced by touch, there is in general no essential difference, as regards the time free from labor, between blind and seeing; small differences speak in favor of the seeing.

2. In persons blind from birth the acuteness of the sense of touch is somewhat less than in seeing persons; in a few cases the rest of the sensorium also suffers in persons blind from birth.

3. The blind have a less acute sense of touch in the tip ends of the forefingers than the seeing; and in the blind, in many cases, there is a difference between the two forefingers, as regards the faculty of receiving impressions.

4. The blind need, especially as regards the hand, a stronger impression than the seeing if a distinct impression of touch is to be produced.

5. In the power to locate the direction of the sound there is no difference between blind and seeing.

6. The ability to locate the direction of the sound varies in the blind as much as in the seeing, and in both is to a very great degree shaped by the individuality of each person.

7. As a general rule, the direction of the sound is determined by the blind and seeing more accurately by hearing with both ears than only with one ear.

8. There is no difference between the blind and seeing as regards the distance at which a sound can be heard and located.

9. There is no relation between the distance at which sounds can be distinguished and the ability to locate them, either in blind or seeing.

10. There is no difference between the blind and seeing as regards the acuteness of the sense of smell.

11. The blind to a greater degree get tired by manual labor than the seeing of the same age.

12. The blind of the same age get tired quicker by manual labor than by mental work; this is not the case with the seeing of the same age.

13. There is no essential difference in the degree of tiredness by mental work between the blind and seeing of the same age. Slight differences speak in favor of the seeing.

14. Both among the blind and seeing there are persons without, with few, and with many erroneous observations. In examining the various parts of the skin, most of these erroneous impressions are received by the cheek bone; very few by the ends of the fingers.

15. The number of erroneous impressions, both in the blind and seeing, increases with the increasing number of irritations (Reize) and increased pressure.

16. Sharp points often produce in blind and seeing erroneous impressions more frequently than blunt points, etc.

Professor Griesbach has expressed himself with the utmost caution in these conclusions, probably with the view not to be considered as a prejudiced opponent of the general opinion; for it is a fact that his tables as to *acuteness of touch* and ability to locate show a very considerable superiority of the seeing; in the forefinger of the right hand this superiority varies between 0.42 and 0.90, or applied to the average "distances" of the seeing, between 40 per cent and 138 per cent. (Figures in the table express millimeters):

		Seeing.	Blind.	Difference.	Per cent.
Table LX and Table LXII.	Holiday.......	0.95	1.37	0.42	44
Table LIX and Table LXI.	Manual labor..	1.40	2.0	0.60	43
Table XLII...............	Holiday.......	0.65	1.55	0.90	138
Table XLII...............	Mental work...	1.36	1.91	0.55	40

These are the "small" differences in favor of the seeing!

In looking over these figures, we are involuntarily reminded of the words of Scripture: "Whosoever hath, to him shall be given, and he shall have more abundantly; but whosoever hath not, from him shall be taken away even that he hath."

Griesbach's conclusions Nos. 11 and 13 deserve a closer examination.

No. 11 agrees with the results of the measurements, but it has not the significance which could be assigned to it, and which has been assigned to it. The conclusion reads: "The blind, to a greater degree, get tired by manual labor than seeing of the same age."

According to Table LXII, the total "distances" of *seeing*, examined in *free* time, therefore, under normal conditions, amounted, in millimeters, to 2.5 + 2.5 + 0.9 + 0.9 + 2.93 + 1.1 + 0.95 = 11.78.

In a state of tiredness after manual labor (Table LXI) we find for the *seeing*: 4.2 + 4 + 4 + 1.55 + 1.32 + 4.43 + 1.5 + 1.4 = 18.70.

The difference between the normal and the tired condition therefore amounts to 6.92 millimeters or 59 per cent of the normal length of "distances." The *coefficient of tiredness*, *i. e.*, the figure by which the normal figures would have to be multiplied to find the degree of tiredness, is 1.587.

In the *blind* the total of the "distances" in *normal conditions*, *i. e.*, of rest, is, according to Table LX, 3.2 + 3.2 + 1.5 + 1.4 + 3.15 + 1.2 + 1.37 = 15.02, whilst the total of "distances" after work in a workshop, according to Table LIX, is: 5.97 + 5.84 + 2.275 + 2 + 6 + 1.7 + 2 = 25.78.

Difference between normal and tired condition: 10.76 = 71.7 per cent.

Coefficient of tiredness: 1.716.

The difference is, therefore, not very great, and is caused by the prolongation of the "distances," already long, as regards the forehead, cheek-bone, and thick part of the thumb. *After mental work* the proportion is reversed in a very striking manner. Conclusion No. 13 does, therefore, *not* agree with the figures.

For the *blind* the total of the "distances" in normal conditions is, according to Table XXXVI, 3.6 + 3.7 + 1.7 + 1.5 + 3.79 + 1.29 + 1.55 = 17.13.

After mental work, Table XXXV: 4.5 + 4.9 + 1.86 + 1.72 + 4.80 + 1.49 + 1.91 = 21.18.

Difference between normal and tired condition, 4.05 = 23.6 per cent.

Coeffieient of tiredness: 1.236.

For the seeing (Table XXXVIII):

Normal condition of rest: 2.3 + 2.4 + 0.9 + 0.9 + 2.4 + 0.83 + 0.8 = 10.53.

After mental work, Table XXXVII: 4.2 + 4.4 + 1.55 + 1.36 + 4.1 + 1.36 + 1.38 = 18.35.

Difference: 7.82 = 74.2 per cent.

Coefficient of tiredness: 1.743.

Strange to say, the percentage for the seeing is three times as large as that for the blind, whilst it says in No. 13 of Griesbach's conclusions that there is no essential difference, and that there are slight differences in favor of the seeing.

This phenomenon can hardly be sufficiently explained by physiology; some psychological elements will have to be brought in and taken into account. It can only be explained by the closer attention of seeing pupils (many blind are inclined to indulge in day dreams), possibly also by a tiredness of the eyes, which, *e. g.*, in writing, are actively engaged as well as the hand, whilst the blind, in writing from dictation, or from memory, properly speaking, exercises no organ of sense, but simply the muscles of the forearm.

For the present it will be well not to draw general conclusions from these figures, because at this time it is impossible to state accurately what instruction preceded these measurements.

Under all circumstances, nothing that has been stated can be cited in support of a vicariate of the senses. Only taste and *touch* can therefore be taken into account. Griesbach has not examined the organs of these two senses. It might be found difficult to find incitants on which the organs of these two senses react in the same manner, though to a different degree. It has recently been attempted by Italian physicians by means of the electric current and different solutions—bitter, sweet, salty. But they do not seem to have obtained any very important results; at any rate, they have not shown any superiority of the blind. To make a second examination of these results, it would, under all circumstances, be necessary to know the strength of the current, the consistency of the solutions, as well as—on account of the persistence of the sensations—the duration of the interruptions between the various experiments; and also the order in which the solutions above referred to were applied. I have never heard that the blind are considered special gourmets; for if this were so, some one would surely have proposed to appoint them on vessels not only as fog compasses, but also as kitchen inspectors. They would doubtless prefer the last-mentioned positions. Possibly from reasons of economy, people have not ascribed to them magic powers.

Nor has an investigation been made concerning the sensibility of the nerves of the skin as regards differences of temperature and resistance of the atmosphere. Possibly it would pay to supplement the ingenious experiments of Th. Heller.

It is well known that totally blind persons who move about freely in comparatively rare cases bump their head against anything. Our pupils play and run about almost like seeing children in the yards and gardens, where there are many trees, and which are mostly enclosed by walls or buildings. Of course, occasionally they run against something—this world was not made specially for blind people—but as a rule they "notice" the hindrance and get out of the way in time. It was thought that this fact, known for a long time, could not be explained by the use of the known senses, and the necessity was felt to ascribe to the blind a seventh sense—"the sense of distance." For more than a century mystic speculations regarding this (non) sense have produced fantastic and many-colored blossoms, but no fruit. In reality, as Th. Heller has also shown, the question is only to use the well-known senses attentively, more especially the capability of touch of the skin of the face (sensation of pressure) and of the sense of hearing. Differences of temperature and the sense of smell are occasionally made the subject of observations. The blind themselves cannot tell how they notice impediments in their way before they touch them; all they can say is that they "feel" them. But they become uncertain and clumsy if, from some reason or other, they must be "blindfolded," or when the ground is covered with snow (or with some other matter which weakens the sound). As soon as there is snow on the ground, even those who know the court best will lose their way in it. How can the fact be explained that to cover up the "eyes," and possibly a part of the forehead, weakens the assurance of the blind? Is the only cause this: that a portion of the skin of the face is covered and that, consequently, the space exposed to the air is *diminished? Experiments* relative to these questions *would have to* be made in the *air bath,* where therefore there would be a much *larger space of exposed skin.* Or is it possible that the nerves of sight, not yet completely dead, play a part in this matter?

Is it not possible that these remnants of the nerves of sight are more sensitive to differences of temperature and to the suddenly increased resistance of the air than the nerves of the skin? (As a teacher of the blind, I address these questions to medical men.) It is evident that in rapidly approaching an impediment—tree or wall, etc.—a temporary condensation of the atmosphere, respectively a back current, is created. Every sharpshooter knows how his rifle rebounds when he aims at a firm, if even distant, object. Even the leafless branches of a tree or shrub increase the resistance. Do the seeing feel such a pressure of the air when rapidly approaching an impediment as certainly as the blind? (In slow approach, even, the blind person runs against objects much easier.) The question remains open, however, whether we are confronted with a superiority of the blind in a *physiological* sense, or whether the psychic element of greater attention on the part of the blind produces the difference. I am inclined to believe the latter.

The sound of steps which changes in the neighborhood of a wall probably has more importance as a warning signal—at least it comes sooner—than the sensations of pressure on the skin of the face. The lack of assurance which shows itself when the floor of the room is covered by a new carpet or the ground is covered with snow proves this.

The so-called "sense of distance" (Fernsinn) is, therefore, only the *sum of all the observations by the senses* which indicate to the blind and to the seeing, when compelled to take notice of it, the approach of danger; you might just as well speak of a "warning sense."

A (physiological) superiority of the sensorium of the blind over that of the seeing has so far not been proved, even as regards taste and touch. But even if experiments in this regard should prove a superiority of the blind, it would hardly be sufficient to make up for the deficit of the other senses, which has been clearly shown by Griesbach. Even then we could not speak of a general sharpening of the sensorium through the loss of one sense; otherwise the loss of hearing would act on the other senses so as to refine and sharpen them, and the loss of the two most important senses would strengthen the others in a very noticeable manner. The results of the measurements show that this is not the case in our deaf-blind. The uncertain swaying walk of the deaf-blind—they generally walk like persons who are drunk—seem to show that the sixth sense, the "sense of equilibrium," has also suffered, *i. e.,* that the *"hydrostatic balance"* (Wasserwage) in the labyrinth of the ear is out of order, which again permits a conclusion concerning the often unknown cause of deafness. Recently two Italian physicians, Dr. Carlo Ferrai, of Genoa ("Sul compenso sensoriale nei sordomuti"), and Dr. Cesare Rossi, of Como ("Sulle durate del processo psichico elementare e discriminativo nei sordomuti"), have examined a *large number* of deaf and hearing persons, and have arrived at the same result. Dr. Ferrai has examined the sense of touch, the "muscle-sense," the "sensation of pain" (caused by the electric current), the sense of smell, and the sense of taste (bitter, sweet, salty). In his "conclusioni" he lays special stress—and refers to Griesbach—on the fact that a "compenso sensoriale," a vicariate of the senses, exists just as little in the deaf as in the blind.

Dr. Rossi expresses his conviction, based on the observations and experiments made by himself and others, that, to say the least, the *strength of sight* of the deaf is not superior to that of hearing persons. He also calls to mind many cases where deafness and blindness go together.

Where one member suffers, all suffer! How could it otherwise be explained that deafness and blindness so often go together. For a number of years, 5 to 6 per cent of our blind have been also deaf; others are hard of hearing; whilst otherwise, among 1,000 persons, hardly more than three deaf (3 per 1,000) are found. This cannot be proved with absolute accuracy, because the term "deafness" is just as elastic in its meaning as "blindness." To the oculist a person is blind who cannot distinguish day from night; to the teacher of the blind, any one is blind who cannot see sufficiently to work by the aid of the eyes. I therefore consider the statistics of the blind and the deaf as entirely unreliable as long as a fixed standard has not been established. Most parents hesitate to enter the words "blind" or "deaf" in the census blanks.

Thanks to the thorough and conscientious investigations of Griesbach and others, the dogma of the "vicariate of the senses" falls to the ground; like many another dogma which for centuries has ruled this or that science, it has had to give way to the results of scientific investigation.

And who would regret this? Those who by nature have been deprived of one or more of their senses are not benefited either by an *overestimation* or an *underestimation* of their capacities.

The ruins of the venerable building will probably for many years to come look down into the valley from the sunny heights of pedagogical and other wisdom, but finally time will also level these ruins!

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Kunz, Martin
The physiology of the blind.
1908.

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